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AVIONICS ADVANCED DEVELOPMENT STRATEGY

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INTRODUCTION

THIS PAPER IS CONCERNED WITH THE PROBLEM OF HOW TO PUT TOGETHER AN INTEGRATED, PHASED, AND AFFORDABLE AVIONICS ADVANCED DEVELOPMENT PROGRAM THAT LINKS AND APPLIES TO OPERATIONAL, EVOLVING, AND DEVELOPING PROGRAMS/VEHICLES, AS-WELL-AS THOSE IN THE PLANNING PHASES. COLLECTING TECHNOLOGY NEEDS FROM INDIVIDUAL PROGRAMS/VEHICLES AND PROPOSED TECHNOLOGY ITEMS FROM INDIVIDUAL DEVELOPERS USUALLY RESULTS IN A MISMATCH AND SOMETHING THAT IS UNAFFORDABLE. A STRATEGY TO ADDRESS THIS PROBLEM WILL BE OUTLINED WITH TASK DEFINITIONS WHICH WILL LEAD TO AVIONICS ADVANCED DEVELOPMENT ITEMS THAT WILL FIT WITHIN AN OVERALL FRAMEWORK, PRIORITIZED TO SUPPORT BUDGETING, AND SUPPORT THE SCOPE OF NASA SPACE TRANSPORTATIONS NEEDS.

SCOPE OF NASA SPACE TRANSPORTATION

THE SCOPE OF SPACE TRANSPORTATION SYSTEMS UNDER CONSIDERATION CAN BE GROUPED BY MAJOR FUNCTIONAL AREAS: CARGO TO LOW-EARTH-ORBIT (LEO), CARGO AND PEOPLE TO LEO AND RETURN TO EARTH, ON-ORBIT TRANSPORTATION AND SERVICES, PEOPLE RESCUE, LEO FACILITY, AND MARS EXPLORATION. THESE ARE SHOWN IN FIGURE 1; ALONG WITH THE VEHICLES WITHIN THOSE AREAS AND THEIR DEGREES OF MATURITY. VERY FEW ARE OPERATIONAL, WITH SOME IN

PHASE C/D DEVELOPMENT, BUT MOST ARE IN PRELIMINARY DEFINITION PHASES. THESE MAJOR FUNCTIONAL AREAS WILL BE REQUIRED TO SUPPORT NASA PROGRAMMATIC GOALS FOR AT LEAST THE NEXT 20 YEARS AND PROBABLY LONGER. THEREFORE, UPGRADING AND EVOLVING EXISTING VEHICLES AND CAPABILITIES BECOMES AN ADDED DIMENSION TO DEFINING, BUILDING AND PHASING IN NEW VEHICLES AND CAPABILITIES.

MANY STUDIES ARE UNDERWAY WITHIN THESE FUNCTIONAL AREAS TO INVESTIGATE OPTIONS CONCERNING UPGRADING AND EVOLVING EXISTING CAPABILITIES, AUGMENTING WITH NEW CAPABILITIES AND/OR STARTING OVER WITH A "CLEAN SHEET" DESIGN. FOR EXAMPLE THE NEXT MANNED TRANSPORTATION STUDY HAS COMPLETED PHASE I WHICH LOOKED AT TRANSPORTATION ARCHITECTURAL OPTIONS ASSOCIATED WITH THE CARGO TO LEO AND CARGO AND PEOPLE TO LEO AND RETURN TO GROUND FUNCTIONAL AREAS. THIS STUDY IS PLANNED TO CONTINUE INTO PHASE II WITH MORE DETAILED DEFINITION AND COSTING STUDIES. IN THE AREAS OF ON-ORBIT TRANSPORTATION AND SERVICES ADDITIONAL STUDIES WILL BE/ARE BEING MADE TO UNDERSTAND THE EVOLUTION OF THE OMV, DEFINITION OF THE OTV, ROBOTIC SERVICER, PLATFORMS, AND FREE FLYERS. THE SPACE STATION (LEO FACILITY) IS NOT A TRANSPORTATION VEHICLE PER SE BUT IS A VITAL PART OF THE TOTAL SPACE TRANSPORTATION PICTURE IN THAT SIGNIFICANT REQUIREMENTS ARE PLACED ON OTHER TRANSPORTATION FUNCTIONAL AREAS BY IT AND IT CAN ALSO BE A JUMPING OFF POINT (TRANSPORTATION NODE) FOR VARIOUS MARS EXPLORATION SCENARIOS. SPACE STATION EVOLUTION STUDIES ARE IN PROGRESS.

EXPLORATION STUDIES ARE UNDERWAY TO

DEFINE TECHNICAL AND PLANNING INFORMATION AND SHOULD BE AVAILABLE IN EARLY 1990. WHILE VARIOUS ASPECTS AND RELATIONSHIPS ACROSS THE FUNCTIONAL AREAS ARE CONSIDERED DURING THESE STUDIES, AN END-TO END ASSESSMENT AND DEFINITION IS REQUIRED TO UNDERSTAND AND DERIVE AN INTEGRATED AND PHASED SET OF AVIONICS ADVANCED DEVELOPMENT NEEDS.

STRATEGY DEVELOPMENT

THIS TOP DOWN APPROACH TO DEFINING AN AVIONICS ADVANCED DEVELOPMENT PROGRAM INVOLVES SEVERAL STEPS: DEFINING PROGRAMMATIC GOALS AND REQUIREMENTS, PERFORMING ASSESSMENTS, DERIVING AVIONICS TECHNOLOGY NEEDS, ESTABLISHING SELECTION CRITERIA, AND APPLYING THE CRITERIA TO PROPOSED TECHNOLOGY DEVELOPMENTS.

THE PROPOSED STRATEGY DEVELOPMENT WOULD BEGIN WITH THE COLLECTION OF CANDIDATE/PROPOSED SPACE TRANSPORTATION SYSTEMS, CONCEPTS, AND SCENARIOS AS DEFINED BY THE ABOVE MENTIONED STUDIES. ESTABLISHMENT OF NASA PROGRAMMATIC/USER NEEDS, PRIORITIES, AND SCHEDULES: FIRST, THOSE ASSUMED WITHIN EACH STUDY, AND SECOND, THOSE WHICH WOULD APPLY ACROSS FUNCTIONAL AREAS WOULD BE THE SECOND TASK. THE NEXT TASK WOULD INVOLVE AN ASSESSMENT OF MIXED FLEET OPERATIONS ACROSS ALL FUNCTIONAL AREAS TO DETERMINE ALTERNATE VEHICLE STRATEGIES AND SYNERGISTIC FLEET CAPABILITIES. WITH THE MIXED FLEET OPERATIONS UNDERSTOOD, THE VEHICLE, SYSTEM, AND OPERATIONS

DDT&E DRIVERS AND PRIORITIES CAN BE DEFINED. THE NEXT STEP IS TO CORRELATE THE DDT&E DRIVERS TO AVIONICS TECHNOLOGY DRIVERS.

THE PAYBACKS AND RISKS OF EACH OF THESE DRIVERS SHOULD BE EVALUATED AND UNDERSTOOD. WITH THIS COMPOSITE SET OF DATA AND INFORMATION THE ESTABLISHMENT OF A SET OF TECHNOLOGY SELECTION AND EVALUATION CRITERIA BECOMES THE NEXT TASK. THIS CRITERIA COULD INVOLVE MANY PARAMETERS SUCH AS; TIMING, FLIGHT TEST REQUIREMENTS, GREATEST PAYBACK ACROSS FUNCTIONAL AREAS, ETC.

SOME OF THE AVIONICS TECHNOLOGY DRIVERS CAN BE GROUPED ACCORDING TO THEIR TIME PHASED SUPPORT TO SEVERAL PROGRAMS/VEHICLES. THESE SHOULD BE IDENTIFIED AND WORKED BY ONE SOURCE OVER A LONGER PERIOD OF TIME IN A BUILD UP FASHION TO SUPPORT THE VARIOUS PROGRAMS/VEHICLES. FIGURE 2 SHOWS THREE EXAMPLES WHICH APPLY TO OPERATIONAL PROGRAMS AS-WELL-AS PLANNED PROGRAMS/VEHICLES. IF THESE TECHNOLOGIES ARE WORKED AS A FUNCTIONAL TYPE (RATHER THAN BY PROGRAM/VEHICLE) MULTIPLE START UP COSTS AND "REINVENTION OF THE WHEEL" CAN BE AVOIDED. ALSO THE FUNDING TO SUPPORT THESE TYPE EFFORTS CAN BE BUDGETED OUT OVER THE YEARS TO MATCH THE TIMING REQUIREMENTS OF THE TECHNOLOGY NEEDS.

RECOMMENDATION

EARLY IN 1990 MUCH OF THE INPUT DATA AND INFORMATION NEEDED TO INITIATE THE ABOVE TASKS WILL BE AVAILABLE. IT IS RECOMMENDED THAT A SMALL WORKING GROUP BE FORMED AND TASKED TO WORK THIS AVIONICS ADVANCED DEVELOPMENT STRATEGY. THE OBJECTIVE BEING TO

DEVELOP A FRAMEWORK FOR ASSESSING AND INTEGRATING AVIONICS ADVANCED DEVELOPMENTS WHICH WILL RESULT IN A PRIORITIZED AND PHASED DEVELOPMENT ITEMS TO SUPPORT NASA SPACE TRANSPORTATION NEEDS.

SYMPOSIUM FEEDBACK AND OBSERVATIONS

COMMENT FROM ALS: THEY ARE SKEPTICAL THAT A PRIORITIZED SET OF ADVANCED DEVELOPMENT ITEMS CAN BE DEVELOPED BASED ONLY ON TECHNICAL MERIT. ALS HAD TRIED TO DO BUT HAD RUN INTO TOO MANY POLITICAL FACTORS.

COMMENT FROM MDAC: AN ANALYTICAL TOOL EXIST THAT WILL PRIORITIZE ITEMS BASED ON VARIOUS COMBINATIONS OF WEIGHTING FACTORS.

OBSERVATIONS:

1. THE AVIONICS TECHNOLOGY NEEDS TO SUPPORT THE VARIOUS PROGRAMS/VEHICLES WERE NOT SPECIFIC OR COMPLETE ENOUGH; ESPECIALLY, FOR THE ON-ORBIT TRANSPORTATION AND SERVICES, SPACE STATION, AND LUNAR/MARS EXPLORATIONS PROGRAMS.

2. IT IS NOT CLEAR WHERE QUESTIONS THAT ARE CONCERNED WITH TRADES BETWEEN NASA HQ CODES SHOULD BE REFERRED TO. THE REQUIREMENT FOR A NASA CHIEF ENGINEER TYPE FUNCTION AT HQ WAS DISCUSSED.

ACRONYMS

ACRC - ASSURED CREW RETURN CAPABILITY

ALS - ADVANCED LAUNCH SYSTEM

AMLS - ADVANCED MANNED LAUNCH SYSTEM

CERV - CREW EMERGENCY RETURN VEHICLE

CRS - CREW RESCUE SYSTEM

CRV - CARGO RETURN VEHICLE

EDO - EXTENDED DURATION ON-ORBIT

OMV - ORBITAL MANEUVERING VEHICLE

OTV - ORBITAL TRANSFER VEHICLE

PLS - PERSONNEL LAUNCH SYSTEM

STS - SPACE TRANSPORTATION SYSTEM (SHUTTLE)

SS - SPACE STATION

SSF - SPACE STATION FREEDOM

Figure 1. Scope of Transportation Needs and Maturities

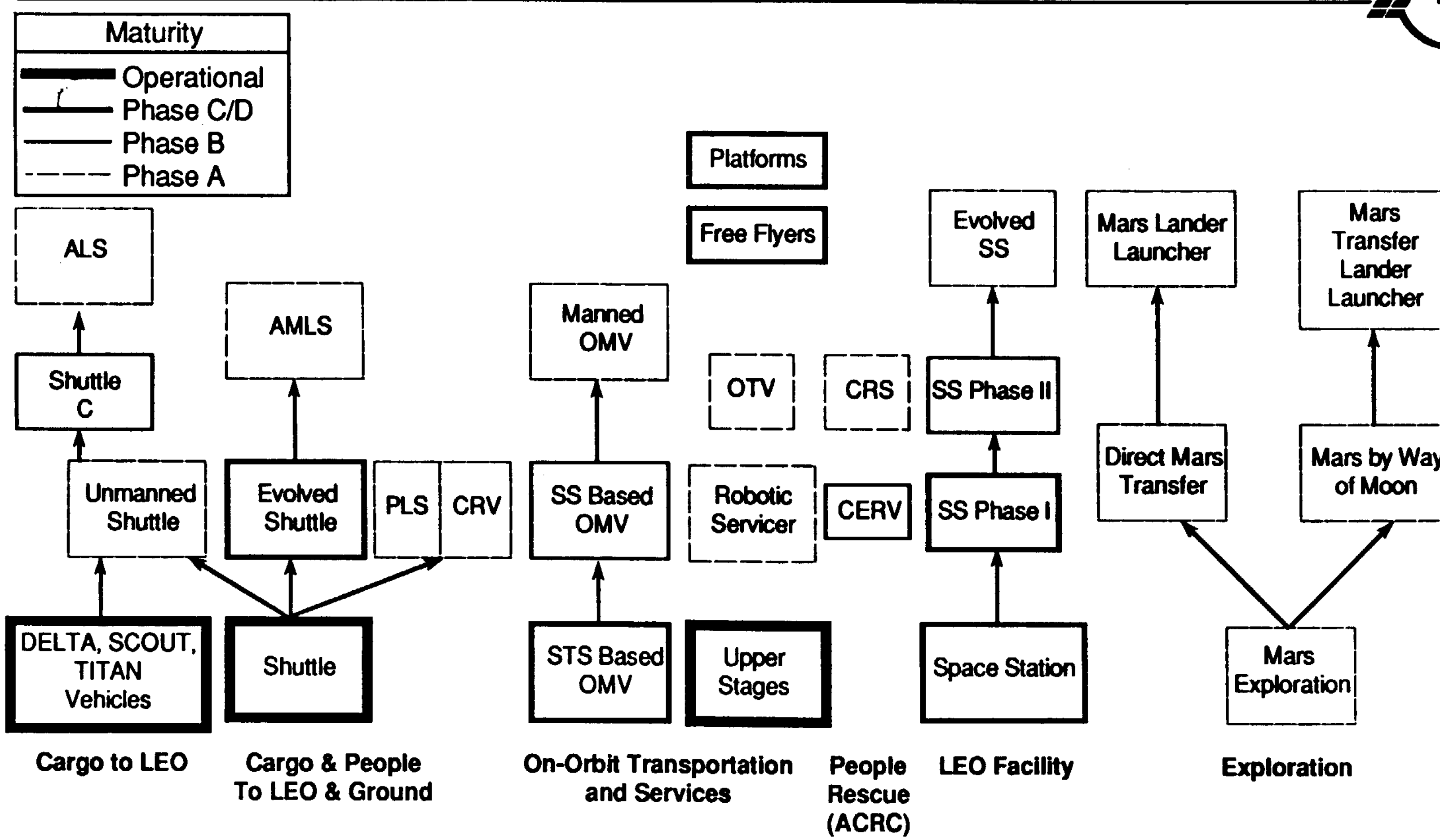

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Figure 2. Examples of Across Program Functional Types

FREEDOM

INFLIGHT MAINTAINABILITY FOR LONG DURATION MISSIONS

- NSTS - To Support Extended Duration On-orbit (EDO)
- SSF - External and internal maintenance and logistics
- CERV - Long-term dormant avionics with quick activation
- Mars Transfers - To support functional availability and redundancy

INFLIGHT CREW TRAINING

- NSTS - To support landings after an EDO
- SSF - To support Phase II and growth station operations
- Mars - To support landings after long transfer times

AUTOMATIC RENDEZVOUS AND DOCKING

- NSTS - Unmanned flights
- SSF - To support man tended free flyer return to station
  - To support OMV/platform return to station
  - To support unmanned resupply
- OMV - To support approaches to orbiter, platforms, and satellites
- Mars - To support Mars sample return mission

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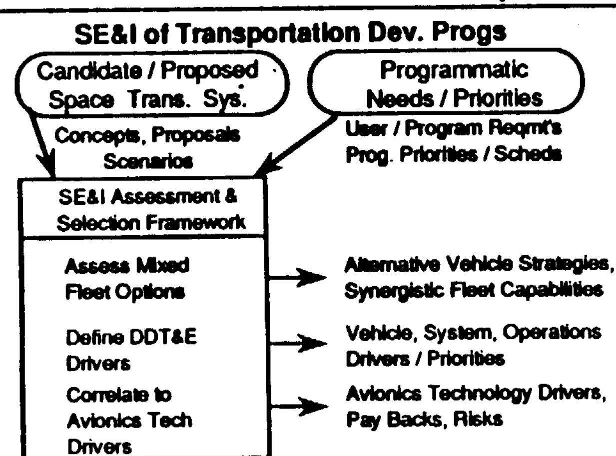
Space Transportation Avionics Technology Symposium
Systems Engineering and Integration
Avionics Advanced Development Strategy

November 1989

FREEDOM

Advanced Avionics Concepts



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Facilities:

Major Objectives

Develop framework for assessing and integrating avionics advanced technology developments

- Priority and phasing of future space transportation systems
- Integration across multiple programs/projects
- Selection/Evaluation criteria

Major Milestones (1990 – 1995)

- **Assimilate results/status of various transportation systems studies (Mid to late 90)**
  - Manned Space transportation
  - Lunar/Mars exploration initiative
  - Cerv, ext. duration orbiter
- **Develop initial framework for assessing/prioritizing tech. needs (mid FY 90)**
- **Apply framework (FY 91)**

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FREEDOM

Technology Issues

- **Integration of transportation needs**
- **Standard, pre-declared criteria for assessing:**
  - Fleet options
  - Design drivers
  - Technology focus
- **Systematic assessment of sensitivities of options & corresponding risks (Tech/Prog)**

Candidate Programs

- **Manned transportation systems**
  - Shuttle evolution
  - CERV
  - Manned Mars/Lunar Missions
- **Unmanned transportation Sys**
  - OMV
  - OTV
  - Mars/Lunar Missions

Major Accomplishments

- MRSR Phase B studies under way
- Manned space transportation study/definition under way
- Lunar/Mars exploration initiative under way

Significant Milestones